10:24 a.m.

1022MP-171 **Beta-Blocker Use in Heart Failure: Should We Pick Up the Pace in Patients With Low Heart Rates?**

Eric C. Stecker, A. M. Fendrick, Bradley Knight, W. B. Fields, Keith D. Aaronson, University of Michigan, Ann Arbor, MI

Background: Beta blocker (BB) therapy reduces death and hospitalizations in patients with CHF. However, patients with low resting heart rates (HR) are often excluded from BB treatment. We hypothesized that prophylactic pacemaker (PM) insertion to facilitate BB use in these patients would save lives at an acceptable cost. **Methods:** A Markov model simulated the natural history of a cohort of clinically stable CHF patients (EF ≤ 35%, mean age 60) with a resting HR of 60 bpm. Two strategies were evaluated: 1) Conventional therapy ("conventional") - risks of death and hospitalization were derived from the ACE inhibitor arm of the SOLVD treatment trial; 2) Dual chamber PM insertion and carvedilol therapy ("PM/BB") - risk reductions of death and CHF-related hospitalizations for carvedilol compared to conventional therapy were derived from the US Carvedilol Study. A Cox regression model showed that baseline mortality and the death and hospitalization benefits with carvedilol were independent of resting HR. For the base case, carvedilol benefits were assumed to persist for two years, tapered off over the next three years, and were gone after five years, while PM-related adverse events persisted. Costs and PM complication rates were based on published data, Medicare payment rates and average wholesale drug prices. **Results:** The PM/BB strategy led to an increased mean survival of 1.6 years (conventional – 6.7; PM/BB – 8.3). These benefits incurred an incremental discounted cost of $8,000 (conventional - $31,000; PM/BB - $39,000). The discounted incremental cost-effectiveness for the PM/BB strategy was $6,200 per life-year saved. In one-way sensitivity analyses, we varied the costs, complication rates and the mortality and hospitalization benefits with carvedilol between 0.5 and 1.5 of base case values. Results were most sensitive to changes in cost of hospitalization, cost of PM placement, and degree and duration of carvedilol benefit but did not exceed the economically attractive threshold of $40,000 per life-year saved. **Conclusion:** Prophylactic PM insertion to facilitate carvedilol treatment in CHF patients with low resting HR has the potential to produce substantial clinical benefits at an acceptable cost.

10:36 a.m.

1022MP-172 **Need for Increased Referral of Minorities to Heart Failure Clinics**

Jacob Joseph, Yufen Huang, Paula Roberson, Roberta Monson, Jeannine Finn, Ileana Piña, University of Arkansas for Medical Sciences, Little Rock, AR, University Health System Consortium, Chicago, IL

Racial differences in outcomes of heart failure (HF) have been postulated. We hypothesized that a nationwide survey of inpatients with HF will enable better delineation of the impact of racial factors, specifically delivery of care.

Methods: We analyzed the 2000 University HealthSystem Consortium (UHC) sponsored survey of inpatient HF. These surveys were done by analyzing patients admitted consecutively, to UHC member hospitals (n=1239). Baseline demographics, medication use, utilization of resources and outcomes were compared among Caucasians (C: n=701) and African Americans (AA: n=373). Other races were not included due to insufficient numbers.

Results: AA were significantly younger (AA 62.5 years vs C 70.5 years; p<0.0001), had more admissions due to drug noncompliance (25.7% vs. C 9.8%; P<0.0001), and a higher systolic (AA 146.6mmHg vs C 136.8 mmHg; p<0.0001) and diastolic blood pressure (AA 82.7 mmHg vs. C 73.2mmHg; P<0.0001). There were no significant differences in the use of angiotensin converting enzyme inhibitors, diuretics, warfarin, antiarrhythmics, inotropes or spironolactone. Beta blockade was used in less AA (15.3% vs C 20.3%; p=0.0479). Digoxin use was also significantly less in AA (47.5% vs 56.2%; p=0.007). Analysis of utilization of resources showed no significant differences in the use of cardiac catheterization, cardiology consultation, or HF service consultation. Referral to outpatient HF clinic was done in more AA (20.4%) than C (15.8%), but this trend was not significant (p=0.06). Complication rates (arrhythmias, infection, stroke, renal failure, cardiorespiratory arrest) were similar (AA 33% vs C 33.4%). Mean length of stay (LOS) was lower in AA, but did not reach statistical significance (AA 5.08+/-3.43 days vs C 5.85+/-4.74 days)

Conclusions: AA patients were younger with a higher rate of noncompliance, and higher blood pressure on admission. Interestingly, a slightly reduced LOS was observed in AA which indicates the possibility of lower risk admissions (due to noncompliance and hypertension) preventable by aggressive HF clinic follow-up. In addition, the rates of beta-blockade use in both groups were low, indicating the need for aggressive follow-up.

POSTER SESSION

1023 Computer Applications in Procurement of Scientific and Evidence-Based Research

Sunday, March 30, 2003, 9:00 a.m.-11:00 a.m.
McCormick Place, Hall A
Presentation Hour: 9:00 a.m.-10:00 a.m.

1023-51 **Micro Transducers to Profile Pulsatile Shear Stress With Vascular Inflammatory Responses**

Tzung K. Hsiai, University of Southern California, Los Angeles, CA, California Institute of Technology, Los Angeles, CA

Introduction: Cell-cell interactions are one of the critical events to inflammatory responses. The important interaction between flow regulation and cell behavior warrants the creation of highly sensitive but small transducers. Emerging Micro Electro Mechanical Systems (MEMS), comparable to the size of EC with a frequency response in the kHz range, provide the high spatial and temporal resolution to link real-time shear stress with the biological activities of vascular endothelium.

Methods and Results: MEMS shear stress sensors were operated based on the heat transfer principle. The heat convection from a resistively heated element to the flowing fluid was measured, from which a value for shear stress was inferred. A linear relation between V^2 (voltage) and $t_w^{1/3}$ (shear stress) can be obtained as $V^2/R\&contains; t^{1/3}$.The flow system was designed to generate well-defined temporal and spatial shear stress gradients. Real-time shear stress in response to pulsatile vs. oscillatory flow was validated with the theoretical formulation of pulsatile flow for our channel, which can be accessed on-line at http://ojps.aip.org/abme. Time-dependent events of monocytes/EC binding kinetics in response to oscillatory shear stress (t) at ± 2.6 dyn/cm^2 were visualized with cell-tracking velocimetry. We observed unique trajectories of individual monocytes in locomotion undergoing cell-cell binding and dissociation, followed by solid adhesion on EC. Our high resolution spatiotemporal analysis linked the nonlinear kinetics of cell-cell interactions with real-time shear stress. The values of shear stress at which these cell-cell interactions occurred were statistically random within the dynamic range of ± 2.6 dyn/cm^2(Reynolds numbers from 0 to 22.2).

Conclusion: The MEMS sensors offer an entry point to directly measure real-time oscillatory shear stress with unprecedented temporal and spatial resolution. In a microfluidic environment, biochemical mediators, not shear stress, dominated the binding affinity of monocytes to EC.

1023-52 **Case-Base Distance Measurements for the Selection of Controls in Case-Matched Studies: Application in Coronary Interventions**

Mariann Gyongyosi, Meinhard Ploner, Gerold Porenta, Wolfgang Sperker, Paul Wexberg, Christoph Strehblow, Dietmar Glogar, University of Vienna Medical Center, Vienna, Austria

Background. The main hypothesis of the presented study was that, if the matching baseline parameters were at least nearly perfectly selected, then the outcomes of the matched pairs should be similar, or no significant differences in study outcome should be observed between the patients and the matched controls.

Methods. In the present study, the case-base domain was created from 1566 patients who had undergone intracoronary stent implantation. Uni- and multivariate logistic regression analysis determined 9 significant predictors (matching variables) for the occurrence of major adverse cardiac events. An additional 425 consecutive patients undergoing intracoronary stent implantation were then matched with all the potential controls from the database by calculating the individual distance between the patient and the matched control on the basis of the elaborated retrieval algorithm.

Results. With "flexible" distance measurements, the mean distance between the patients and the first matched controls was 1.31. The major adverse cardiac events were compared in the patient and matched control groups. The best sensitivity and specificity values of the matching system could be achieved in matched pairs with the distance≤3 (95.1% of all patients). On the further stepwise exclusion of the matched pairs exhibiting a distance greater than 2 and 1, then the number of "matchable" controls and the specificity of our matching concept decreased considerably. When the short- or mid-term outcome was compared by using the long-term follow-up matching parameters, no correlation could be found between the treated subjects and controls, indicating, that for other study main measures other appropriate parameters must be selected. Furthermore, the outcome measures of the patients and randomly (non-systematically) selected controls did not correlate, revealing the impossibility of drawing correct study conclusions from a non-matched, randomly assigned pairs. **Conclusion.** The sensitivity and specificity of the matching program and the study conclusions depend on the appropriately predefined matching parameters and retrieval algorithm.

1023-53 **Automatic Correction of Pressure Distortion by Fluid-Filled Systems: A Novel Statistical Frequency Domain Approach**

Ernst Wellnhofer, Juergen Hug, Evgeni Potapov, Bertin Bluemcke, Eckart Fleck, DHZB, Berlin, Germany

The aim of the study was to develop an automatic correction of the pressure errors resulting from fluid-filled catheter systems (FFS) with the catheter in place and without disturbing running measurements.

Methods: Algorithm: A continuously up-dated estimate of the transfer function (TF) is derived in the frequency domain using the pressure signal from the FFS as input. The main resonant frequency (RF)and the damping coefficient (DC) of the FFS are determined from the Fourier spectra of the pressure signal. Spectra with strong artifacts or noise are excluded by correlation analysis. The phase and a first estimate of the magnitude of the TF are derived from RF and DC (model: damped oscillator). Magnitude above RF is sensitive to additional resonant sites and is improved by further analysis of the shape of the spectra. Correction is performed with the inverse function of the estimated TF.

Tests: In-vitro 20 different pressures (left/ right ventricle, aorta, pulmonary artery, right atrium) were tested in 23 different FFS. In-vivo in 5 pigs 456 hemodynamic interventions were performed with pharmacologic agents, and atrial pacing at heart rates up to 180b/ min with 16 different FFS in the right and left ventricle, in the aorta and pulmonary artery (reference Millar tip sensors).

Results: The improvement of accuracy was significant for all pressure parameters.

Results

	Systolic error (mmHg)	Diastolic error (mmHg)	dP/dt max error(mmHg/ sec)	dP/dt min error (mmHg/sec)	RF (Hz)	DC
in-vitro without correction	5+-5	3+-3	301+-218	247+-211	10+ -8	0.25 +-0.2
in-vitro with correction	1+-1	1+-1	42+-37	34+-35	11+ -7	0.27 +- 0.18
In-vivo without correction	6+-5	2+-2	312+-157	85+-76	12+ -5	0.23 +- 0.15
in-vivo with correction	3+-2	1+-1	157+-173	34+-28	13+ -5	0.29 +- 0.15

Conclusion: The accuracy of pressure recordings by use of fluid-filled systems in clinical practice may be significantly improved by this automatic algorithm.

1023-54 A New Computerized Method to Trace Mitral Anulus in Three-Dimensional Space From Three-Dimensional Echocardiographic (RT3DE) Image: An In Vitro Validation Study

Giuseppe Saracino, Takahiro Shiota, Qin Jian Xin, James D. Thomas, Cleveland Clinic Foundation, Cleveland, OH

Accurate measurement of the curved length of mitral annulus is not possible using conventional 2D Echocardiography. In our lab, a new custom-made computer which aids us to trace mitral anulus in 3D space has been developed. The aim of this study is to validate this new technique for measuring the curved length of mitral annulus.

Methods

Ten (10) phantoms mimicking ten mitral annuli of known curved length have been built. The curved length of the phantoms ranged from 79 mm to 160 mm. All phantoms were imaged using RT3DE. After transferring acquired data to a commercially available computer, our custom-made software has been used for determining the curved length of the simulated mitral anulus. A 3D reconstruction of the simulated anulus is shown to the operator who manually traces the contours of the mitral anulus without knowing its actual length. The traced 3D curve is superimposed on the original 3D dataset so that the operator can evaluate the accuracy of the tracing. Once tracing of the mitral anulus has been completed, its curved length is automatically calculated by the computer.

Results

Using our novel user interface, it was easy to accurately trace all the simulated mitral anuli. A simple linear regression analysis showed an excellent correlation and agreement between measured and actual length ($y = 0.94x + 6.6$; $r = 0.99$, mean difference = 2.74 ± 2.61 mm).

Conclusion

Our new 3D method has provided easy tracing and accurate measurement of simulated mitral annuls, which is a complex curve in 3d space. This new computer method may contribute for clinical use of RT3DE, especially for patients with mitral disorder.

1023-55 Creation of a Mathematical Model to Define Circumferential Linear Lesion Length for Pulmonary Vein Isolation

James D. Maloney, Elisa M. Konieczko, Shailaja Tekulapally, John M. Oshlick, Sreela Sasi, Hamot Hospital, Erie, PA, Gannon University, Erie, PA

Background: Circumferential continuous linear lesions that isolate the pulmonary veins (PV) from the left atrium (LA) are effective in curing atrial fibrillation. Methods to define the needed lesion length, and to confirm its completion, are dependent upon development of a mathematical model and a software program for computer assisted mapping of the heart.

Methods: A mathematical formula was developed and tested using measurements taken from adult cadaver hearts. Measurements taken included: 1) the distances between the four PV ostia, 2) the distances between superior and inferior venous pairs, and 3) the diameters of the veins. Actual circumferential linear lesion length was measured in each heart. A mathematical model determining the total circumferential path length of lesions around the endocardial ostia of PV within the LA was developed. The actual lengths and the computed lengths were compared.

Results: For this model, R_1, R_2 = PV radii; D = minimal horizontal distance between PV; P = minimal distance from R needed to prevent PV stenosis; θ_1, θ_2 = angles subtended at the PV center. This formula can be adapted for ablations of common PV [D=0: $2p(R+P)$], closely spaced PV [D< 2P: $R_1(360-\theta_1)\ p\ /180 + R_2(360-\theta_2)\ p\ /180$], or widely spaced PV [D≥ 2P: $2p(R_1+R_2+D)$] or [$(R_1+R_2) + 2(P+D)$]. Formulae generated circumferential lesion lengths closely correlated with actual lengths taken from cadaver hearts.

Conclusions: These formulae can: 1) accurately predict circumferential linear lesion length, 2) be used in both catheter based and surgical based PV isolations, and 3) can be incorporated into software for electroanatomic mapping systems to provide lesion length guidelines and confirmation of lesion delivery.

1023-56 Accuracy of Aortic Valve Area Calculation Using a Computer-Based Planimetry System in the Catheterization Laboratory

Fernando Boccalandro, Hela C. Achour, Andreas Muench, Richard Kirkeeide, Richard W. Smalling, University of Texas Houston Medical School, Houston, TX

Background: New computer based systems are capable of performing automatic algorithms for planimetry and instantaneous aortic valve area calculations using the Gorlin principle, if a proximal central aortic catheter is used to record peripheral pressures avoiding significant waveform delay and augmentation. Although used daily in clinical practice, the accuracy of these new systems had not been validated in patients with aortic stenosis. The purpose of this study is to compare the correlation and agreement of computed automatic aortic valve area calculations obtained from interventricular and proximal aortic pressures against standard planimetry, and evaluate the need for tracing realignment when a proximal aortic catheter is used to measure peripheral tracings.

Methods: Twenty two patients (15 males, mean age:68 ±11 Years) referred for invasive aortic valve evaluation for aortic stenosis were studied with a two transducers fluid filled system and a 6F interventricular pigtail catheter though a 7F proximal descending aortic long sheath. Aortic valve area was calculated using the Gorlin formula with a standardized paper tracing planimetry method and the computer based automatic planimetry (GE Medical. USA) using thermodilution cardiac outputs. All the tracings were completed with paper speed of 100 mm/sec. The need for tracing realignment was examined for each patient and the correlation and agreement of valve area calculations was analyzed with a Spearman's rank order correlation and a Bland-Altman Analysis.

Results: The mean delay between aortic and interventricular tracings was 30±7 msec, none of the patients required tracing realignment. The mean frequency response was 31± 4 Hz. The correlation coefficient between automatic aortic valve area calculation and standard planimetry was 0.892 ($p<0.001$) with a positive bias of 0.2 cm2 towards the automatic method ($p<0.001$). **Conclusions:** Automatic computer based aortic valve area calculations can be accurately made placing a catheter into the left ventricle and in the proximal descending aorta with out tracing realignment using the new computer systems available in the catheterization laboratory for patients with aortic stenosis.

1023-57 Wireless, Batteryless Micro ElectroMechanical Systems (MEMS) Sensors for Continuous Cardiac Pressure Monitoring: Initial Animal Experience

Achiau Ludomirsky, Gregory J. Ensing, Eric J. Devaney, Collin A. Rich, Matthew Z. Straayer, James Cripe, Nader Najafi, University of Michigan, Ann Arbor, MI, Integrated Sensing Systems (ISSYS), Ypsilanti, MI

Background: Intracardiac pressures are commonly used in the assessment of patients with heart disease. Continuous monitoring of hemodynamics would improve patient care. The introduction of Micro-electromechanical Systems (MEMS) may enable the clinician to continuously monitor cardiac physiology. The purpose of this study was to assess the feasibility and accuracy of a new MEMS pressure sensor in monitoring a wide range of cardiac pressures.

Method: The sensors(size = 10/10/3 mm -15/5 /5 mm) were fabricated using MEMS and were powered by and communicate via wireless magnetic telemetry with an external monitor. The batteryless, wireless sensors were implanted in the right atrial appendage and in the descending aorta of two dogs. Millar solid state catheters were used to record pressure data from locations adjacent to the MEMS sensors. Blood pressure wave forms derived from the new MEMS sensor were compared to pressure tracings from Millar catheters.

Results: Excellent correlation was found between the new MEMS sensor and Millar tracings. The system was capable of real time output (200 Hz band width) of continuous blood pressure wave form with -200 to +300 mmHg dynamic range and 0.5 mmHg resolution at the telemetry distance of 3-4 cm from the chest wall.